- ***INHERITANCE PATTERNS:***

- ***THE BIRTH OF MODERN GENETICS ,MENDELIAN INHERITANCE PATTERNS ,OTHER INERITANCE PATTERNS,ENVIRONMENTAL EFFECTS AND GENE EXPRESSION:***

  - **MENDELIAN INHERITANCE PATTERNS:**

INHERITANCE PATTERN

Syllabus Chapter 7/3
The birth of modern Genetics: Mendelian Inheritance pattern, other inheritance pattern, Environmental effects and gene expression

MENDELIAN INHERITANCE PATTERN

PRINCIPLE OF SEGREGATION

The law of Mendel states that **the allele of gene present on the homologous chromosomes segregates during meiosis in such a way that each gamete get one allele not both**. The genes in each parent are incorporated into separate gametes during gamete formation. The homologous chromosomes move towards opposite poles of the cell during anaphase I of meiosis. Therefore, the gametes have only one member of each chromosome pair. The allele of genes present on one member of a pair of homologous chromosomes enters into one gamete. The other allele of that gene is present on the other member. These alleles are segregated into a different gamete. There is random combination of gametes during fertilization. It brings homologous chromosomes together again.

Proof of Principle of segregation

There are two types of fruit flies (Drosophila):

- Wild-type fruit flies: They have normal wings.
- Vestigial wings: They have very reduced wings.

True breeds

These flies are taken from the true breed stock. These flies have been inbred for many generations. Thus they breed true for wild type wings or vestigial wings.

F_1 Cross

The wild type flies are crossed with the vestigial wing flies. The offspring of this cross have wild-type wings in F_1 generation.

F_2 cross

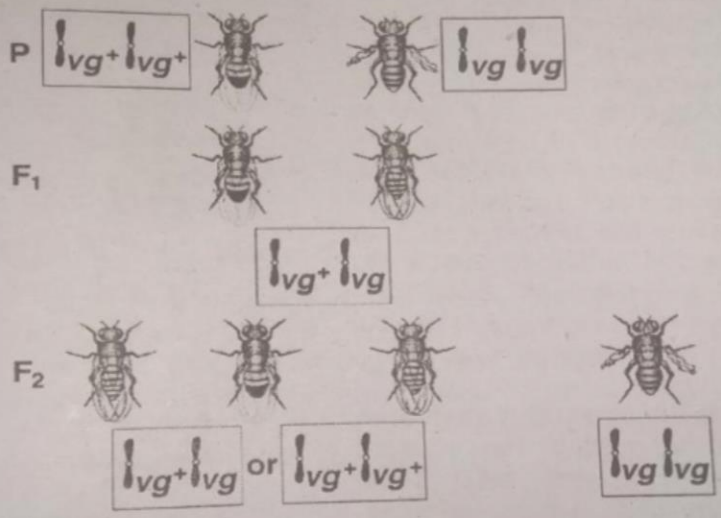
The F_1 flies are allowed to mate with each other. The progeny of F_2 generation has:

- One fourth has vestigial wings.
- Three-fourths have wild wings.

The vestigial characteristic disappears in the F_1 generation. But it reappears in the F_2 generation. The ratio of wild-type files to vestigial-winged flies in the F_2 generation is approximately 3:1.

Reciprocal crosses

The cross with same characteristics but a reversal of the sexes of the individuals is called reciprocal cross. This cross gives similar results.

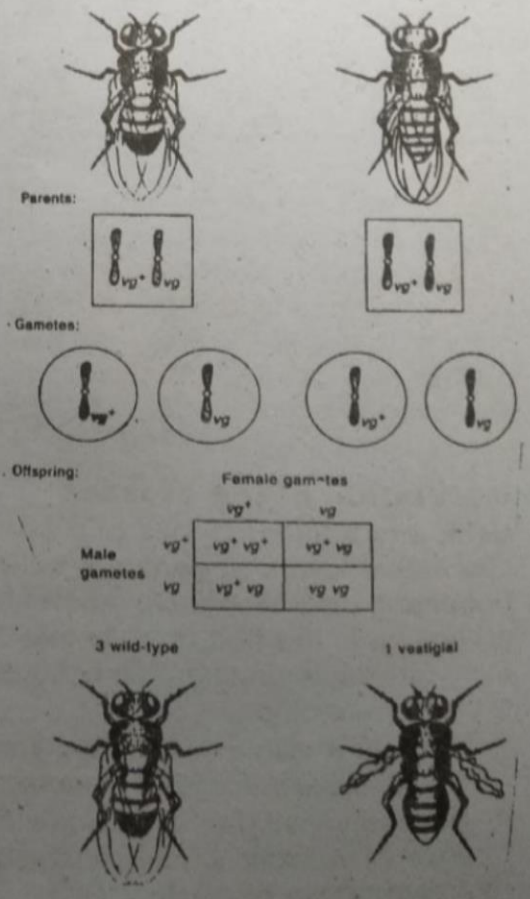


Interpretation of the crosses

1. **Gene and alleles:** Genes of a particular trait exist in alternative forms. **The alternative forms of gene are called alleles.**
2. **Dominant and recessive alleles:** The vestigial allele is present in the F_1 generation in the fruit fly. It is masked by the wild-type allele for wing shape. But it retains its uniqueness because it is expressed again in some members of the F_2 generation.
   - **Dominant allele hides the expression of recessive alleles.** The wild-type allele is dominant. It masks the expression of the vestigial allele.
   - **Recessive alleles are those whose expression can be masked.** The allele of vestigial wing is recessive.
3. **Representation of alleles:** Crosses are expressed by letter or letters. These

letters are descriptive of the trait in question. The first letter of the description of the dominant allele is commonly used. In fruit flies, the mutants are compared with a wild-type. The symbol is taken from the allele that was derived by a mutation from wild condition. A superscript "+" is written next to the symbol. It represents the wild-type allele. A capital letter means that the mutant allele is dominant. A small letter means the mutant allele is recessive.

4. **Phenotypes and genotypes:**
   - **The physical expression of a gene is called phenotype.** The physical expression of alleles does not indicate the genetic makeup of an organism.
   - **The genetic makeup is called the genotype:** The F_1 generations have the same phenotype as one of the parents. But they carry both dominant and recessive alleles. So they differ genotypically. They are called hybrids. This cross concerns only one pair of genes and a single trait. So it is a monohybrid.
5. **Homozygous and heterozygous:** An organism is homozygous if it carries two identical genes for a given trait. Thus all members of the parental generation are homozygous. An organism is heterozygous if the genes are different. Only true-breeding flies are crossed. All members of the F_1 generation are heterozygous.
6. **Punnett square:** Punnett square is used to predict the result of crosses. The first step is to determine the kinds of gametes. One of the two axes of a square is designated for each parent. The different kinds of gametes are listed along the axis. The gametes are combined in the interior of the square. It shows the results of random fertilization. The figure indicates that the F_1 flies are heterozygous. These flies have one wild-type allele and one vestigial allele.

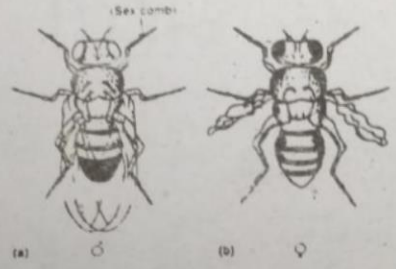


The two phenotypes of the F_2 generation shows 3:1 ratio in Punnett square. The phenotypic ratio expresses the results of a cross. This result is obtained from the relative numbers of progeny in each class. The Punnett square has thus explained in another way the F_2 results in figure. It also shows that F_2 individuals may have one of three different genotypes. The genotypic ratio expresses the results of a cross according to the relative numbers of progeny in each genotypic category. These are 1 vg^+ vg^+: 2 vg^+ vg: 1 vg vg.

INDEPENDENT ASSORTMENT

It states that, **"When alleles of more than one trait are followed together in cross, the alleles of these traits assort independently to each other during gamete formation."** It is also possible to make crosses using flies with two pairs of characteristics:

- **Mutants:** These are flies with vestigial wings and sepia eyes. Sepia eyes are dark brown. These are represented as vg, se
- **Wild type:** The flies are wild for these characteristics. The wild-type eyes are red. These are represented as vg^+, se^+



F_1 cross

The flies in the parental generation are homozygous for each trait. Therefore, each parent produces only one kind of gamete. Gametes have one allele for each trait. Fertilization takes place. It produces offspring heterozygous for both traits. The F_1 flies have the wild type phenotype. Thus, wild-type eyes are dominant to sepia eyes. The F_1 flies are hybrids. The cross involves two pairs of genes and two traits. Therefore, it is a **dihybrid**.

F_2 cross

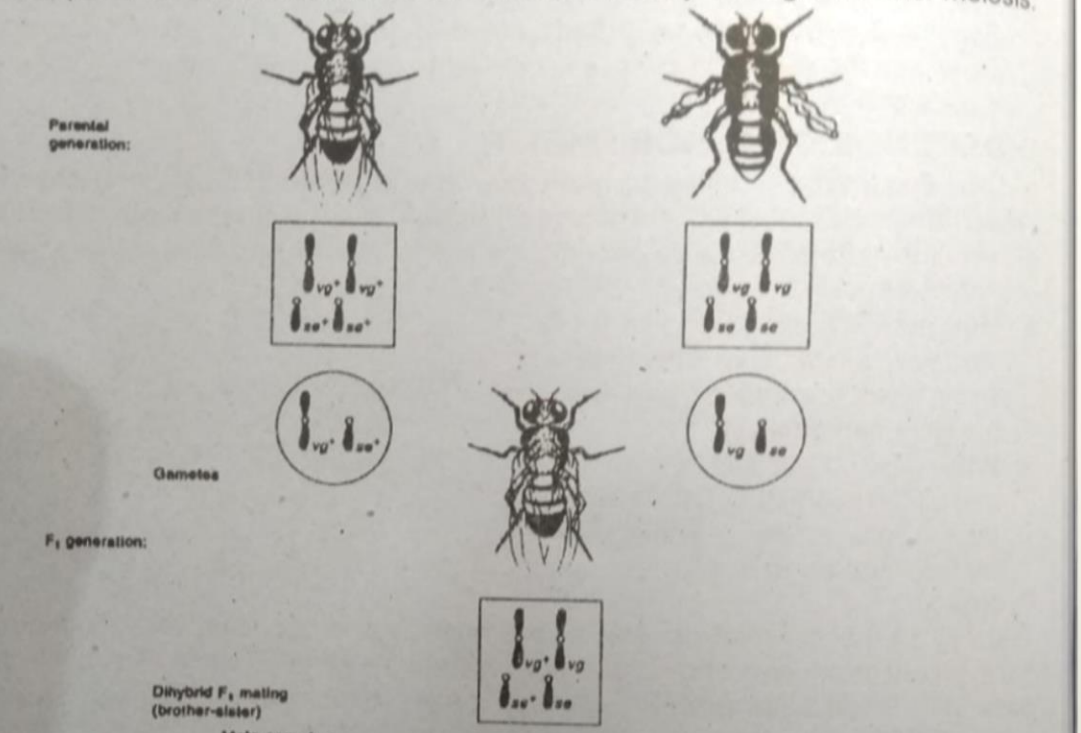
The F_1 hybrids are crossed to obtain F_2. The F_2 gives 9:3:3:1 ratio. It is a typical dihybrid cross ratio. This ratio shows that the alleles have assorted independently.

Interpretation of independent assortment from meiosis

The distribution of genes of one trait does not influence distribution of other gene during gamete formation. F_1 gamete have vg gene for wing condition. It also has the se or se^+ gene for eye color. All the combinations of the eye color and wing condition genes are present. These combinations can form equally. This shows the principle of independent assortment and the pairs of factors segregate independently of one another.

The steps of meiosis explain the principle of independent assortment. Meiosis produces haploid daughter cells. These cells have one member of each

homologous pair of chromosomes. The homologous chromosomes line up at metaphase I. They then segregate from each other. The behavior of one pair of chromosomes does not influence the behavior of any other pair. The maternal and paternal chromosomes are distributed randomly among cells after meiosis.



F_2 generation:

Male gametes \ Female gametes	$vg^+ ; se^+$	$vg^+ ; se$	$vg ; se^+$	$vg ; se$
$vg^+ ; se^+$	$vg^+ vg^+ ; se^+ se^+$	$vg^+ vg^+ ; se^+ se$	$vg^+ vg ; se^+ se^+$	$vg^+ vg ; se^+ se$
$vg^+ ; se$	$vg^+ vg^+ ; se se^+$	$vg^+ vg^+ ; se se$	$vg^+ vg ; se se^+$	$vg^+ vg ; se se$
$vg ; se^+$	$vg^+ vg ; se^+ se^+$	$vg vg^+ ; se^+ se$	$vg vg ; se^+ se^+$	$vg vg ; se^+ se$
$vg ; se$	$vg^+ vg ; se se^+$	$vg vg^+ ; se se$	$vg vg ; se se^+$	$vg vg ; se se$

Phenotypic ratio

9 wild-type wing (vg^+); wild-type eye (se^+)
3 wild-type wing; sepia eye (se)
3 vestigial wing (vg); wild-type eye
1 vestigial wing; sepia eye

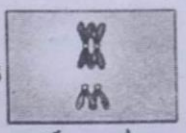
Fig: Law of independent assortment

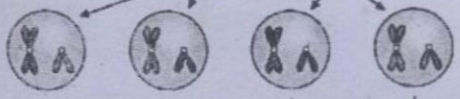
Diploid Cell (2N = 4)

(a)

Prophase I: Synapsis of homologous chromosomes

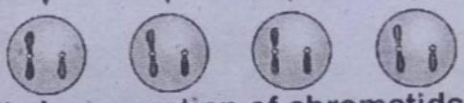
(b)





(c)

Possible combinations of chromosomes in haploid cells after segregation of homologous chromosomes during meiosis I. All possible combinations of one member of each pair is represented.



(d)

Meiosis II results in separation of chromatids but no further reduction in chromosome number.